CLAIMS

1. A system for injecting a blowing agent into polymeric material within a barrel of a polymer processing apparatus, comprising:

a conduit having an inlet connectable to a source of blowing agent and an outlet connectable to a port in the barrel to provide a pathway through which blowing agent flows from the source to the polymeric material within the barrel; and

a flow controlling system including a bypassing passageway fluidly connected to the conduit at a position between the inlet and the outlet, the flow controlling device designed to selectively direct blowing agent flowing from the source to the polymeric material within the barrel, or through the bypassing passageway.

2. The system of claim 1, wherein the polymer processing apparatus includes a screw mounted in the barrel and designed to reciprocate from an accumulation position, in which the screw plasticates polymeric material that accumulates downstream of the screw, and an injection position, in which the screw does not plasticate polymeric material and the accumulated polymeric material is injected through an outlet of the barrel.

3. The system of claim 2, wherein the flow controlling system is designed to direct blowing agent flow from the source through the bypassing passageway when the screw is in the injection position.

4. The system of claim 1, wherein the flow controlling system comprises a valve.

5. The system of claim 4, wherein the valve is positioned at a junction of the conduit and the bypassing passageway and is switchable between a first position directing flow from the source to the barrel and a second position directing flow from the source to the bypassing passageway.

6. The system of claim 4, wherein the flow controlling system further comprises a back-pressure regulator.

7. The system of claim 5, wherein the flow controlling system further comprises a back-pressure regulator located in the bypassing passageway downstream of the valve.

8. The system of claim 6, wherein the back-pressure regulator is designed to maintain a back pressure approximately equal to the pressure of the polymeric material proximate the blowing agent port when a screw rotates in the barrel to plasticate the polymeric material.

9. The system of claim 7, wherein the back-pressure regulator is designed to maintain a back pressure approximately equal to the pressure of the polymeric material proximate the blowing agent port when a screw rotates in the barrel to plasticate the polymeric material.

10. The system of claim 9, wherein the back-pressure regulator is designed to maintain a back pressure of between about 500 psi and 4000 psi.

11. The system of claim 1, wherein an outlet of the bypassing passageway opens to atmosphere.

12. The system of claim 1, wherein an outlet of the bypassing passageway is connected to a recovery container.

13. The system of claim 1, wherein an outlet of the bypassing passageway is connectable to the source of blowing agent.

14. The system of claim 1, wherein the flow controlling system comprises two valves, a first valve in the conduit downstream of a junction of the bypassing passageway and the conduit, and a second valve in the bypassing passageway downstream of the junction.

15. The system of claim 14, including a controller that switches the first valve to an open position when the second valve is closed, and switches the second valve to an open position when the first valve is closed.

16. The system of claim 14, further comprising a back-pressure regulator located in the bypassing passageway downstream of the second valve.

17. The system of claim 15, further comprising a back-pressure regulator located in the bypassing passageway downstream of the second valve.

18. The system of claim 1, wherein the flow controlling system comprises a valve in the conduit downstream of a junction of the conduit and the bypassing passageway, and a back-pressure regulator in the bypassing passageway downstream of the junction.

19. The system of claim 1, wherein the flow controlling system comprises a shut-off valve, and a fluid pathway distance from the shut-off valve to the port in the barrel is no more than 3 inches.

20. The system of claim 19, wherein the fluid pathway distance from the shut-off valve to the port in the barrel is no more than 1 inch.

21. The system of claim 19, wherein the shut-off valve is located essentially adjacent to the port in the barrel.

22. The system of claim 21, wherein the flow controlling system further comprises a second valve located in the bypassing passageway downstream of the junction.

23. The system of claim 21, wherein the flow controlling system further comprises a second shut-off valve in the bypassing passageway downstream of the

junction and a back-pressure regulator in the bypassing passageway downstream of the second valve.

24. The system of claim 21, wherein the flow controlling system further comprises a back pressure regulator in the bypassing passageway downstream of the junction.

25. The system of claim 21, further comprising a check valve between the shutoff valve and the port.

26. The system of claim 25, wherein the flow controlling system further comprises a second valve located in the bypassing passageway downstream of the junction.

27. The system of claim 25, wherein the flow controlling system further comprises a second shut-off valve in the bypassing passageway downstream of the junction and a back pressure regulator in the bypassing passageway downstream of the second valve.

28. The system of claim 25, wherein the flow controlling system further comprises a back pressure regulator in the bypassing passageway downstream of the junction.

29. The system of claim 1, wherein the flow controller system comprises a shut-off valve, wherein an enclosed volume between the shut-off valve and the port in the barrel is less than 0.50 cubic inches.

30. The system of claim 29, wherein the enclosed volume between the shut-off valve and the port in the barrel is less than 0.10 cubic inches.

31. The system of claim 1, wherein the flow controlling system comprises a shut-off valve at least a portion of which is positioned within a bore in the barrel.

32. The system of claim 1, wherein a fluid pathway distance from the bypass valve to the port in the barrel is no more than 5 feet.

33. The system of claim 1, wherein a fluid pathway distance from the bypass valve to the port in the barrel is no more than 1 foot.

34. The system of claim 1, wherein the source of blowing agent continuously supplies blowing agent to the inlet of the conduit.

35. The system of claim 1, wherein the source of blowing agent supplies blowing agent to the inlet of the conduit at a flow rate of less than about 60 lbs/hour.

36. The system of claim 1, further comprising a metering device associated with the conduit, positioned between the source of blowing agent and the barrel port, the metering device constructed and arranged to control the flow rate of blowing agent supplied to the conduit.

37. The system of claim 36, wherein the metering device controls the mass flow rate of blowing agent supplied to the conduit.

38. The system of claim 1, wherein the conduit inlet is connectable to a source of blowing agent that is a gas at ambient conditions.

39. The system of claim 1, wherein the conduit inlet is connectable to a source of blowing agent that is a liquid as delivered to the port in the barrel.

40. The system of claim 1, wherein the conduit inlet is connectable to a source of blowing agent that is a supercritical fluid at conditions in the extruder.

41. The system of claim 1, wherein the blowing agent comprises carbon dioxide.

42. The system of claim 1, wherein the blowing agent comprises nitrogen.

43. The system of claim 1, wherein the polymer processing apparatus comprises a discontinuous plasticating system.

44. The system of claim 43, wherein the polymer processing apparatus comprises an injection molding apparatus.

45. The system of claim 43, wherein the polymer processing apparatus comprises a blow molding apparatus.

46. A system for processing polymeric foam material comprising:

an extruder including a barrel and a screw designed to rotate within the barrel to convey polymeric material in a downstream direction within a polymer processing space between the barrel and the screw, the extruder having a port in the barrel positioned to introduce a blowing agent into polymeric material in the polymer processing space to allow formation therein of a solution of polymer and blowing agent; and

a shut-off valve having an inlet fluidly connected to a blowing agent source and an outlet fluidly connected to the port, the shut-off valve designed to selectively permit or prevent the flow of blowing agent therethrough,

wherein a fluid pathway distance from the shut-off valve to the port in the barrel is no more than 3 inches.

47. The system of claim 46, wherein the shut-off valve is a two-way valve.

48. The system of claim 47, wherein the shut-off valve is switchable between a first position directing flow of blowing agent from the source to the port, and a second position directing flow of blowing agent from the source to a bypassing passageway.

49. The system of claim 47, wherein a fluid pathway distance from the shut-off valve to the port in the barrel is no more than 1 cm.

50. The system of claim 47, wherein the outlet of the shut-off valve is located essentially adjacent to the port in the barrel.

51. The system of claim 47, wherein an enclosed volume between the shut-off valve and the port in the barrel is less than 0.50 cubic inches.

52. The system of claim 47, wherein an enclosed volume between the shut-off valve and the port in the barrel is less than 0.10 cubic inches.

53. The system of claim 47, wherein an enclosed volume between the shut-off valve and the port in the barrel is less than 0.05 cubic inches.

54. The system of claim 47, wherein the port in the barrel comprises a plurality of orifices.

55. The system of claim 47, further comprising a blowing agent injection assembly fluidly connected to the source of blowing agent via a conduit, the blowing agent injection assembly including the shut-off valve and having an outlet comprising the port in the barrel.

56. The system of claim 55, wherein the blowing agent injection assembly is positioned within a bore in the barrel.

57. A blowing agent injection assembly operable with polymer processing apparatus, comprising an inlet and a multi-orifice outlet, the assembly having an internal passageway connecting the inlet to the multi-orifice outlet, the blowing agent injection assembly including a valve coupled to the passageway, the valve moveable between a first position which permits the flow of blowing agent from the inlet to the outlet through the passageway and a second position which prevents the flow of blowing agent from the inlet to the outlet through the passageway.

58. The blowing agent injection assembly of claim 57, wherein the valve is a two-way valve, wherein the second position directs the flow of blowing agent from the inlet to a bypassing passageway.

59. The blowing agent injection assembly of claim 57, wherein the multi-orifice outlet includes at least 10 orifices.

60. The blowing agent injection assembly of claim 57, wherein the blowing agent injection assembly includes at least a portion of the valve inserted within a sleeve, the sleeve defining the multi-orifice outlet.

61. The blowing agent injection assembly of claim 57, further comprising a back-flow restrictor moveable between an open configuration which permits the flow of blowing agent from the inlet to the outlet through the passageway and a closed configuration which prevents the flow of molten polymeric material from the outlet to the inlet through the passageway.

62. The blowing agent injection assembly, wherein the back-flow restrictor comprises a ball check valve.

63. A method of injecting blowing agent into a barrel of a polymer processing apparatus comprising:

continuously supplying blowing agent from a blowing agent source connected to the barrel of a polymer processing apparatus while discontinuously injecting the blowing agent from the source into the barrel.

64. The method of claim 63, further comprising selectively directing the flow of the blowing agent flowing from the source to the polymeric material within the barrel, or through the bypassing passageway.

65. The method of claim 63, further comprising discontinuously plasticating polymeric material in the barrel.

66. The method of claim 64, further comprising selectively directing the flow of the blowing agent from the source through the bypassing passageway when not plasticating polymeric material in the barrel.

67. The method of claim 65, further comprising stopping the plasticating of polymeric material for a time period of less than 15 minutes.

68. The method of claim 63, further comprising reciprocating a screw mounted in the barrel between an accumulation mode, in which polymeric material accumulates downstream of the screw, and an injection mode, in which accumulated polymeric material is injected through an outlet of the barrel.

69. The method of claim 68, comprising directing the flow of the blowing agent from the source away from the barrel when the screw is in the injection mode.

70. The method of claim 64, further comprising maintaining the pressure in a section of the bypassing passageway approximately equal to the pressure of polymeric material in the barrel when a screw rotates in the barrel to plasticate the polymeric material.

71. The method of claim 63, comprising continuously supplying blowing agent at a constant flow rate.

72. The method of claim 63, wherein the constant flow rate is less than about 60 lbs/hour.

73. The method of claim 63, wherein the constant flow rate is between about 0.001 lbs/hour and 10 lbs/hour.

74. The method of claim 63, further comprising injecting polymeric material from an outlet of the barrel into an injection mold.

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75. A method of forming polymeric foam material comprising:

conveying polymeric material in a downstream direction in an extruder within a polymer processing space between a screw and a barrel;

introducing a blowing agent into the polymeric material in the polymer processing space through a blowing agent port; and

preventing the flow of blowing agent to the blowing agent port at a distance of less than 3 inches from the blowing agent port.

76. The method of claim 75, comprising preventing the flow of blowing agent to the blowing agent port at a distance of less than 1 inch from the blowing agent port.

77. The method of claim 75, comprising preventing the flow of blowing agent to the blowing agent port at a location essentially adjacent the blowing agent port.